INSTRUCTIONS

For The

WESTON MODEL 1477
DC MILLIVOLT/MICROAMMETER

DAYSTROM, INCORPORATED
WESTON INSTRUMENTS DIVISION
Newark, New Jersey

F-3116 R-1 2-61 Printed in U.S.A.

TABLE OF CONTENTS

SECTION			PAGE NO.
I		GENERAL DESCRIPTION	1
	1-1.	Instruction Book Coverage	1
	1-2.	Purpose of the Instrument	1
	1-3.	Description of the Instrument	1
	1-4.	Performance Specifications	2
II		THEORY OF OPERATION	4
III		OPERATING INSTRUCTIONS	6
	3-1.	Setting Up the Instrument	6
	3-2.	Preliminary Adjustments	6
	3-3.	Step by Step Operating Procedure	8
IV		MAINTENANCE	10
	4-1.	General	10
	4-2.	Tests and Adjustments	10
	4-3.	Fuse Replacement	11
	4-4.	Replacement of Tubes and Components	11
	4-5.	Trouble Shooting	12
V		REPLACEMENT PARTS LIST	15
	5-1.	General	15

LIST OF ILLUSTRATIONS

FIGURE		PAGE NO.
1-1.	Model 1477 Millivolt/Microammeter	iii
2-1.	Model 1477 Block Diagram	4
4-1.	Accuracy Test Circuit	11
4-2.	Model 1477 Schematic Diagram	13
4-3.	Model 9950 Amplifier Schematic Diagram	14
5-1.	Model 1477, Front View	15
5-2.	Model 1477, Rear View With Case Removed	16
5-3.	Model 9950 Amplifier, Bottom View	20

LIST OF TABLES

TABLE		
1-1.	Table of Specifications	2
1-2.	Source Resistance	3

Figure 1-1. Model 1477 Millivolt/Microammeter

SECTION I

GENERAL DESCRIPTION

1-1. INSTRUCTION BOOK COVERAGE

This instruction book covers the description, theory, operation and maintenance of the Weston Model 1477 DC Electronic Millivolt/Microammeter, shown in Figure 1-1.

1-2. PURPOSE OF THE INSTRUMENT

The Model 1477 is a portable test instrument especially designed to measure potentials and currents in the low-level millivolt and microampere ranges. With sensitive, low-level input elements (such as thermocouples or photocells) it amplifies a small input to a large output which is easily read to a high degree of accuracy. No energy is drawn from the input circuit during steady-state operation. Only with an initial input application is there a small current taken during the transient period prior to steady state indication.

1-3. DESCRIPTION OF THE INSTRUMENT

The Model 1477 consists of three basic Weston Models combined in a single unit: a high torque-to-weight Model 1971 Milliammeter (0 to 1 ma DC) which responds rapidly to single changes, is used as the panel indicator and comprises the front of the Model 1477; a Weston Model 1401 Inductronic Galvanometer is used as the sensing and converting device; and a Weston Model 9950 Amplifier strip provides the balancing current. A high accuracy tapped resistor network and a B+ power supply complete the system.

These components are mounted on a chassis which becomes a compact, lightweight unit when encased. A carrying strap is provided across the top of the instrument.

The Function and Range Selector switches are mounted on concentric shafts and located on the lower right of the instrument front.

The black knob portion of the switch is the function Selector and has three positions: MICROAMPS, OFF, and MILLIVOLTS. These positions are indicated on the scale plate. Setting the Function Selector switch to MICROAMPS or MILLIVOLTS turns on the power to the instrument. Both of these positions are supplied with a neon pilot light to indicate which function is in use. No light appears when the switch is set to OFF.

The clear skirted knob portion of the switch is the Range Selector which is used in conjunction with the switch dial under it. The dial shows all ranges of the instrument on a double scale: black numerals on the outside are current ranges, and red numerals on the inside are potential ranges. A red index mark on the switch skirt indicates the ranges in use.

A zero corrector knob, located at the lower center of the instrument front, is provided as a mechanical means of setting the indicator for either zero left or zero center operation (see Section III, paragraph 3-2.A).

Two input binding posts are mounted on the lower left of the instrument front, along with a third post for a grounding connection. An input jumper link is provided for connections between the input terminals. For convenience in operating, an illustration showing the functions and positions of the three terminals is printed on the scale plate directly above the binding posts.

Two output terminals connected by a jumper are provided on the rear of the instrument to operate an external indicator or recorder if desired.

1-4. PERFORMANCE SPECIFICATIONS

A. GENERAL. Table 1-1 lists the principle features and characteristics of the Model 1477.

DC Input Ranges	
Millivolts	1/2/5/10/20/50/100/200/500/1000
Microamperes	10/20/50/100/200/500/1000
DC Output (Rear Terminals)	1 MA DC for full scale input (into a load up to 5000 ohms)
Accuracy	
Panel Indicator (Both Scales)	±1% of full scale value on ranges of 2-1000 MV and 20-1000 μA
	±2% fo full scale value on ranges of 1 MV and 10 μA
1 MA Output	±0.25% on ranges of 5-1000 MV and 50-1000 μA
	±0.5% on ranges of 1-2 MV and 10-20 μA
Power Requirements	120 volts AC, 50 or 60 cycles, 19 watts
Operating Position	Vertical

Table 1-1. Table of Specifications

B. OVERLOADS. Overload capacities of this instrument are far superior to the usual indicating instrument. On any current range, as much as 65 milliamperes DC can be applied to the input terminals for a reasonable period of time without causing damage or change in calibration. For the potential range, at least 2 volts DC can be applied when set on the lowest range, and at least 25 volts DC applied to the highest range. An approximate linear relationship will apply to the intermediate ranges.

Due to the "saturating" feature in the electronic circuit, a maximum of 2.2 milliamperes DC can be drawn from the output terminals at the rear of the Model 1477. This additional feature means that under any conditions of input overloads, the readout instruments connected to the output will never receive more than about twice overload. This is a distinct advantage in low level measurements where accidental overloads of a high level may occur.

C. SOURCE RESISTANCE. In order to obtain stated accuracies on all ranges, the source resistance when measuring current should be 50 ohms or greater. For voltage measurements, the source resistance should be 50 ohms or less. Other source resistances far from this optimum value may be used but with varying degrees of error. Table 1-2 shows the allowable source resistances for various current and voltage ranges which will give negligible error. This table should be used more as a guide to expected accuracy rather than as a correction table.

CURRENT RANGES		VOLTAGE RANGES	
μA	Ohms	MV	Ohms
10	80	1	10
20	50	2	100
50	30	5	100
100	10	10	500
200	5	20	500
500	3	50	2000
1000	3	100	2000
		200	8000
		500	30,000
		1000	40,000

Table 1-2. Source Resistance

It can be seen that the lowest ranges suffer the most for source resistances which differ greatly from the optimum. High current ranges with very low source resistances cause sluggish pointer action since the feedback loop is not so tight as under optimum conditions. This also is true of high voltage ranges with high source resistances.

SECTION II

THEORY OF OPERATION

It can be seen from the block diagram (Figure 2-1) that a DC input signal first is applied to the Resistance Network. Almost instantaneously after the input has been applied, negative DC feedback rises to a magnitude sufficient to exactly balance the input. Events which occur between this action and reaction are as follows:

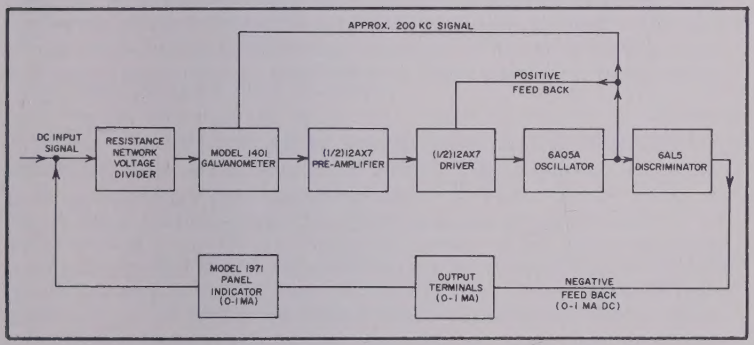


Figure 2-1. Model 1477 Block Diagram

The input signal is applied either direct or in shunt (depending upon whether current or voltage is being measured) with the Model 1401 Galvanometer moving coil. A slight rotation of this coil causes it to couple with 200 KC fed to the Galvanometer field coils from the Oscillator. (In the zero center position, no high frequency signal is coupled.) This small induced high frequency signal now in the moving coil is amplified in the Pre-Amplifier stage. A strong signal now available has certain phase and magnitude relationships with the positive feedback from the Oscillator to the Driver. These two signals mix when going into the Driver so that the coupling network requires the Oscillator to shift frequency from a nominal resting frequency in order to remain phaseless to match an amplifier phaseless transconductance. Thus, with a particular level of DC input, the Oscillator will settle down very quickly to a new operating frequency. A frequency Discriminator of the type usually found in radio circuits provides a DC output in

proportion to the frequency change from nominal. From a zero position, the Discriminator can be driven either positive or negative with equal accuracy and linearity. The final step is to take this Discriminator output as DC milliamperes (1 ma maximum as negative feedback) and feed it to the Galvanometer moving coil to produce a restoring torque. The complete system now remains static under these new operating conditions.

Since the DC feedback is directly proportional to the input signal, it can be used to operate an indicating instrument (Model 1971 Panel Indicator) or can be broken into by removing the jumper link on the two output terminals at the rear of the instrument to drive auxiliary indicating or recording equipment. When using the output terminals, any external load up to 5000 ohms may be connected across these terminals without causing loss in accuracy. A higher load would result in a loss in DC feedback and the system would have difficulty in maintaining balance.

The most important single feature of the Model 1477 is that it is completely "potentiometric", which means that no energy is drawn from the source being measured when measuring either voltage or current. For voltage measurements, the Model 1477 input appears to be an infinite resistance and for current measurements, the input appears to be zero. In actual practice, a minute current of about 0.05 microamperes might be taken from or delivered to the source due to friction and spring torque in the Galvanometer. This current is known as the resolution sensitivity current of the instrument and usually is small enough to be ignored.

Another important feature of the Model 1477 is that it responds only to the average of a signal other than DC. Since much ripple is symmetrical in form, it does not alter the indication of the DC component.

SECTION III

OPERATING INSTRUCTIONS

3-1. SETTING UP THE INSTRUMENT

The Model 1477 is shipped completely assembled, wired and ready for operation. To assure specified accuracy on the lowest ranges, the instrument should be operated on a fairly level test bench with the indicator vertical although no damage will occur if operated in any other position. When tilted back to approximately 45°, only the higher ranges (500μa and up, or 50 mv and up) can be depended upon for a negligible change in accuracy since the Galvanometer pivots are no longer vertical and any mechanical unbalance in the moving system will tend to rotate the coil. Readjustment of the Galvanometer (see paragraph 3-2.C) can be performed in a particular position to maintain good accuracy.

3-2. PRELIMINARY ADJUSTMENTS

Before operating the Model 1477, check to see that the instrument is functioning correctly and is properly adjusted, both mechanically and electrically, by means of the following procedures:

A. MECHANICAL ADJUSTMENT.

1. Set FUNCTION SELECTOR switch to OFF.
2. If required, set POINTER exactly on left end ZERO mark of the scale by means of the ZERO CORRECTOR knob located at the lower center face of the instrument panel.

NOTE: If the Instrument is to be used as a null detector, set POINTER to center ZERO mark of the bottom set of scale divisions on the dial.

B. OPERATIONAL CHECK.

1. Plug LINE CORD into 120 volt, 50 or 60 cycle power source.
2. Set FUNCTION SELECTOR switch to MICROAMPS or MILLIVOLTS and allow instrument to warm up for a few minutes to assure stability of the electronic circuit. The neon pilot light below the selected function should be on.

NOTE: Setting the Function Selector switch to either MICROAMPS or MILLIVOLTS turns on the power to the Model 1477. Do NOT set FUNCTION SELECTOR switch to OFF between operations or when using the instrument intermittently. This will shut off the power supply to the amplifier section and the instrument will have to be warmed up with each operation.

3. Observe position of pointer. The pointer may move off scale or drift across the scale.

NOTE: At this point, the Range Selector switch can be in any position and the input jumper on the input terminals can be connected in any combination. No damage will occur to the Model 1477 even if the pointer is off scale or is drifting across the scale.

4. Set RANGE SELECTOR switch to LOWEST μa or mv range (10 μa, or 1 mv).

5. Remove INPUT jumper from INPUT terminals if FUNCTION SELECTOR switch is set to MICROAMPS. If set to MILLIVOLTS, connect INPUT jumper between "+" or "–" INPUT terminals.

6. Observe position of pointer. The pointer should be approximately on zero.

7. Slightly move the Model 1477 on the test bench to disturb the Galvanometer moving coil. The pointer should show a sharp movement up or down scale and return to zero.

NOTE: If an upper range is selected, the effect of Galvanometer disturbance will be smaller and the pointer will move only slightly.

C. ELECTRICAL ADJUSTMENT.

1. Set FUNCTION SELECTOR switch to MICROAMPS or MILLIVOLTS.

2. Set RANGE SELECTOR switch to LOWEST μa or mv range (10μa, or 1 mv) for the most sensitive adjustment of the Model 1401 Galvanometer.

3. Remove INPUT jumper from INPUT terminals if FUNCTION SELECTOR switch is set to MICROAMPS. If set to MILLIVOLTS, connect INPUT jumper between "+" and "–" INPUT terminals.

4. If required, set POINTER exactly on the selected ZERO mark (zero left or zero center) by turning Galvanometer ZERO CORRECTOR screw, located under a hole at the top right of the case, with a ferrous or non-ferrous screwdriver.

NOTE: When placed near the Galvanometer, an iron screwdriver will cause the pointer to jump. However, accurate adjustments can be made if the screwdriver is steadied.

5. All adjustments are now complete and the instrument is ready for use. These adjustments should hold for any position selected by the Function and Range Selector switches. After being warmed up for an hour or more, it may be necessary to make some slight readjustment of the Galvanometer zero corrector for use on the lowest ranges.

3-3. STEP BY STEP OPERATING PROCEDURE

After all preliminary adjustments have been made per paragraph 3-2, the Model 1477 is ready for operation.

1. Set FUNCTION SELECTOR switch to MICROAMPS or MILLIVOLTS as required.
2. Set RANGE SELECTOR switch to HIGHEST microampere or millivolt range (1000μa, or 1000 mv).
3. Remove INPUT jumper from INPUT terminals.
4. Connect LEADS from circuit under test to "+" and "–" INPUT terminals. Polarity markings for the input terminals are shown on the scale.
5. Energize circuit under test and read the indicated value on the panel indicator.
6. If the pointer oscillates or is driven off scale, or if readability is poor, the cause usually may be corrected by means of the following steps:

   a. Pointer moves down and off scale – Reverse POLARITY by reversing INPUT leads.

   b. Pointer moves up and off scale – Remove leads as applied voltage or current is too large to be measured by the Model 1477. Normally, no damage from overloads will result (see Section I, paragraph 1-4.B).

   NOTE: For large DC currents, use a common 50 or 100 mv shunt and read the shunt voltage drop on the panel indicator.

   c. Pointer indicates very low on scale – Set RANGE SELECTOR switch to a LOWER range for improved readability.

   d. Pointer oscillates rapidly over an area approximately 1/16 inch wide – Connect INPUT jumper between GROUNDING terminal and either the "+" or "–" INPUT terminal. This will generally reduce vibration. If circuit conditions permit, a conduit or pipe ground also connected to the grounding terminal may improve stability.

e. Input Terminal Ripple Effect – Some sources being measured with the Model 1477 are affected in their operation by a small amount of 200 KC and 60 cycle ripple appearing at the (+) and (–) input terminals. This ripple can be reduced to a negligible amount by placing a 1 or 2 MFD condenser (of good quality for low leakage) across the (+) and (–) input terminals and by placing a jumper (or link) from the input ground terminal to the (–) input terminal. No other grounds can be applied to the output circuit if this is used. Radiation pick up in a room, 60 cycle for example from fluorescent lamps, can be minimized by tightly twisting all lead pairs or by using shielded leads with an earth ground.

NOTE: Pointer vibration may occur under certain conditions or operation (input containing some 60 cycle ripple, for example). This vibration is not caused by the Galvanometer following the input ripple but rather by the ripple being coupled into the input stages of the electronic circuit. The input circuit is DC isolated from other internal circuits. The grounding terminal is connected to chassis ground. Potentials existing between the circuit under test and the grounding terminal should be limited to a maximum of 100 volts.

7. If the Model 1477 is used to drive auxiliary indicating or recording equipment, remove JUMPER from REAR OUTPUT terminals and make connections directly if the device driven has a 0-1 ma DC current input. If a voltage signal is required, connect a resistor of the proper value (5000 ohms maximum) across the output terminals and take the voltage drop across this resistor.

NOTE: If the auxiliary equipment requires an input circuit ground, do NOT ground the input to the Model 1477, as only one ground can be made.

8. In order to maintain the Model 1477 at operating temperature, leave FUNCTION SELECTOR switch set to MICROAMPS or MILLIVOLTS between operations. Set FUNCTION SELECTOR switch to OFF and remove LINE CORD from power source during extended periods of non-use.

SECTION IV

MAINTENANCE

4-1. GENERAL

This section contains maintenance instructions for the Model 1477 Millivolt/Microammeter. When symptons of malfunctioning are detected, refer to the applicable paragraph and schematic diagrams for probable causes and remedial actions. Be sure the power source used operates at a nominal potential of 120 volts AC and at a frequency of 50 or 60 cycles. Do not plug into a DC line.

As with any pivot and jewel instrument, the Model 1477 should not be subjected to prolonged vibration or shock. Basic accuracy will not deteriorate but the resolution sensitivity will. Thus, more current will be drawn from, or delivered to, the source being measured. Damage to the panel indicator can be determined by a test milliammeter connected to the output terminals as described in paragraph 4-2.A.

With proper care, the Model 1477 should give many years of dependable, trouble free service. The Weston Model 1971 panel indicator and Model 1401 Galvanometer suffer nominal deterioration and most of the electrical components are permanent in nature. Avoid rough handling of the instrument to prevent damage to the Galvanometer pivots. If the Galvanometer is damaged in any way, the Model 1477 should be returned to the Weston plant in Newark, N.J., for repairs. Check the binding posts periodically to make certain they are clean and tight. Any repairs beyond tightening or soldering connections should be performed by the manufacturer.

4-2. TEST AND ADJUSTMENTS

The following tests and adjustments may be performed on the Model 1477 to assure that the instrument is operating properly and within the specified tolerances listed in Section I, Table 1-1:

A. ACCURACY TEST. Connect a 1 ma meter of known accuracy into the output circuit, as shown in Figure 4-1, and feed in a known DC signal to the input of the Model 1477. The test meter and the Model 1477 panel indicator should agree. If the test meter indicates the expected value and the panel indicator does not, then the panel indicator is in error and the system is functioning correctly. If the test meter does not indicate the expected value, the system is not functioning correctly. In either event, the Model 1477 should be returned to the Weston plant, in Newark, N.J., for repairs. Both zero adjustments must be correct during this test (see Section III, paragraph 3-2).

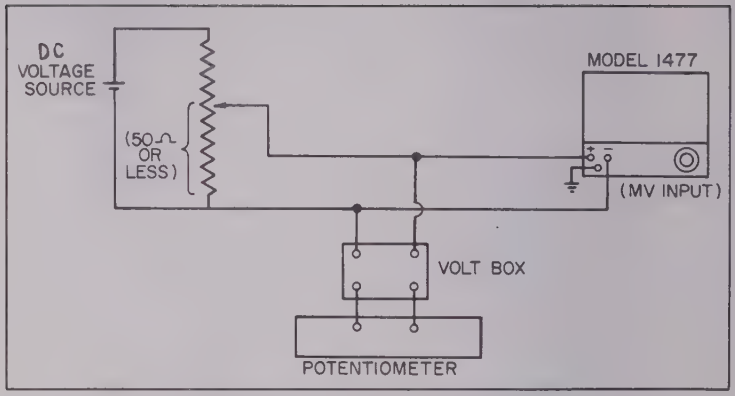


Figure 4-1. Accuracy Test Circuit

B. CALIBRATION ADJUSTMENT. No calibration adjustment is required for the Model 1477 since basic accuracy is determined entirely by the accuracy built into the resistance network. There should be negligible drift in basic accuracy over a long period of time since the resistors used are highly stable wire-wound spools.

C. GALVANOMETER ADJUSTMENT. The Model 1401 Galvanometer normally does not require any adjustment other than possible zero adjustment at installation (see Section III, paragraph 3-2.C). If the Galvanometer becomes damaged in any way, return the Model 1477 to Weston for repairs.

4-3. FUSE REPLACEMENT

A 1 ampere quick-to-medium acting fuse is provided in one line of the 120 volt power cord to protect the circuitry of the instrument and is located at the rear of the instrument on the left side. The outside case must be removed to gain access to the fuse. As in any electronic device, a blown out fuse usually indicates trouble in the circuit.

CAUTION: Do not replace the fuse with one of higher rating. If a fuse blows immediately after replacement, do not replace a second time until the cause has been corrected.

4-4. REPLACEMENT OF TUBES AND COMPONENTS

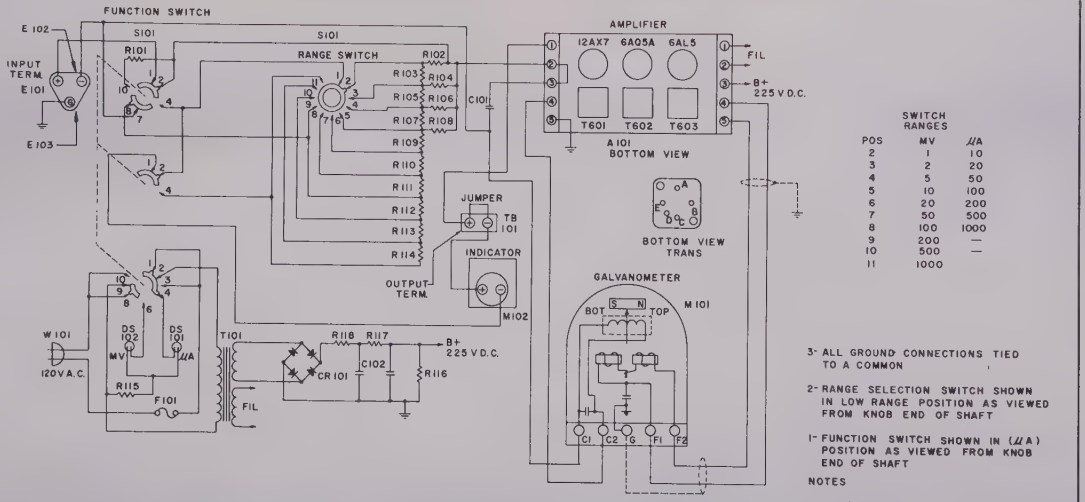
All components used in this instrument are of the highest quality and were carefully selected to reduce replacement problems to an absolute minimum. Under normal operating conditions, the only parts that should need replacement are the fuse, tubes, or pilot lights. All of these components are standard radio parts that can be purchased at any radio parts distributor and do not require any special selection.

The tubes should give several thousand hours of useful service and should be replaced only when the accuracy of the instrument cannot be maintained. The tubes can be checked by any reliable tube checker. Their location on the instrument is shown in Section V, Figure 5-2. It is recommended that a spare set of tubes be kept on hand for replacement purposes. The three electron tubes used in the Model 1477 are: 12AX7 (Pre-amplifier and Driver), 6AQ5A (Oscillator), and 6AL5 (Discriminator).

With routine replacement of the vacuum tubes and careful handling of the instrument, the service life expectancy of the Model 1477 is unlimited. The B+ power supply filter capacitor (C102) is an electrolytic type and may have to be replaced after considerable service.

4-5. TROUBLE SHOOTING

General trouble shooting of circuit or component failures is similar to that for any industrial electronic equipment. Usually, component failures can be detected with standard meters by those familiar with electronic equipment and by use of the schematic wiring diagrams (Figures 4-2 and 4-3).



SWITCH RANGES

POS	MV	μA
2	1	10
3	2	20
4	5	50
5	10	100
6	20	200
7	50	500
8	100	1000
9	200	—
10	500	—
11	1000	

3- ALL GROUND CONNECTIONS TIED TO A COMMON

2- RANGE SELECTION SWITCH SHOWN IN LOW RANGE POSITION AS VIEWED FROM KNOB END OF SHAFT

1- FUNCTION SWITCH SHOWN IN (μA) POSITION AS VIEWED FROM KNOB END OF SHAFT

NOTES

COMPONENT LIST

C101 .02 MFD	R107 10 OHMS .1%	R116 220K 1W 10%
C102 8 MFD (EACH SECTION)	R108 20 OHMS .1%	R117 4K 5W 5%
F101 1 AMP	R109 10 OHMS .1%	R118 47 OHMS .5W 10%
R101 100 OHMS 1%	R110 30 OHMS .1%	T101 POWER TRANSFORMER
R102 10 OHMS .1%	R111 50 OHMS .1%	CR101 RECTIFIER
R103 10 OHMS .1%	R112 100 OHMS .1%	DS101 PILOT LIGHT
R104 30 OHMS .1%	R113 300 OHMS .1%	DS102 PILOT LIGHT
R105 18 OHMS .1%	R114 500 OHMS .1%	
R106 15 OHMS .1%	R115 150K .5W 10%	

Figure 4-2. Model 1477 Schematic Diagram

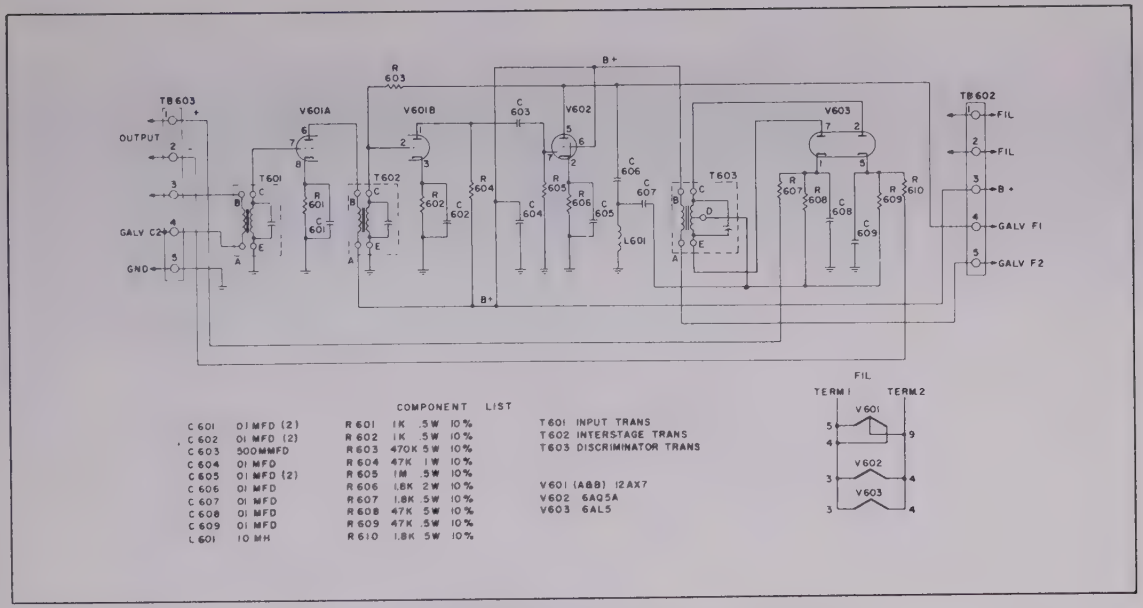


Figure 4-3. Model 9950 Amplifier Schematic Diagram

SECTION V

REPLACEMENT PARTS LIST

This section lists and describes all major electrical components of the Model 1477. Except for those parts specifically designated as being obtainable only from Weston, most of these components are standard commercial parts that can be purchased at any electronics parts distributor.

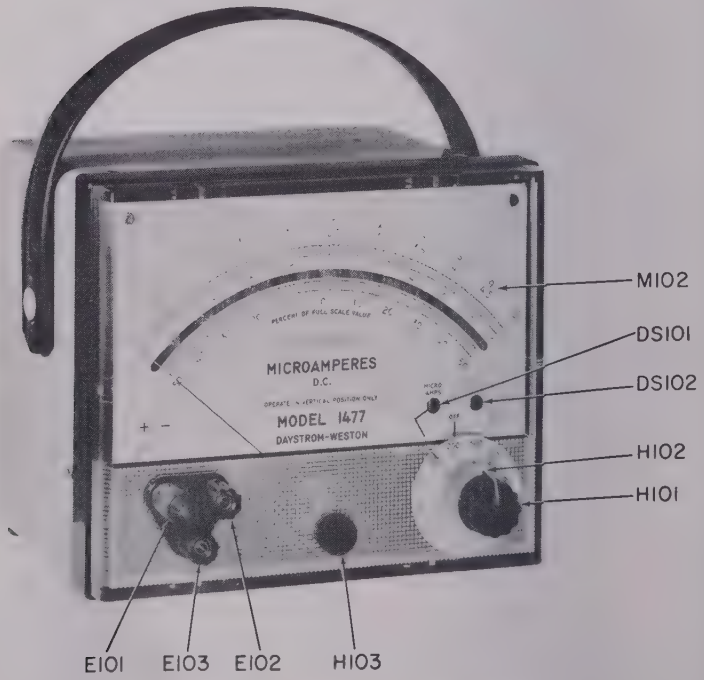


Figure 5-1. Model 1477 Front View

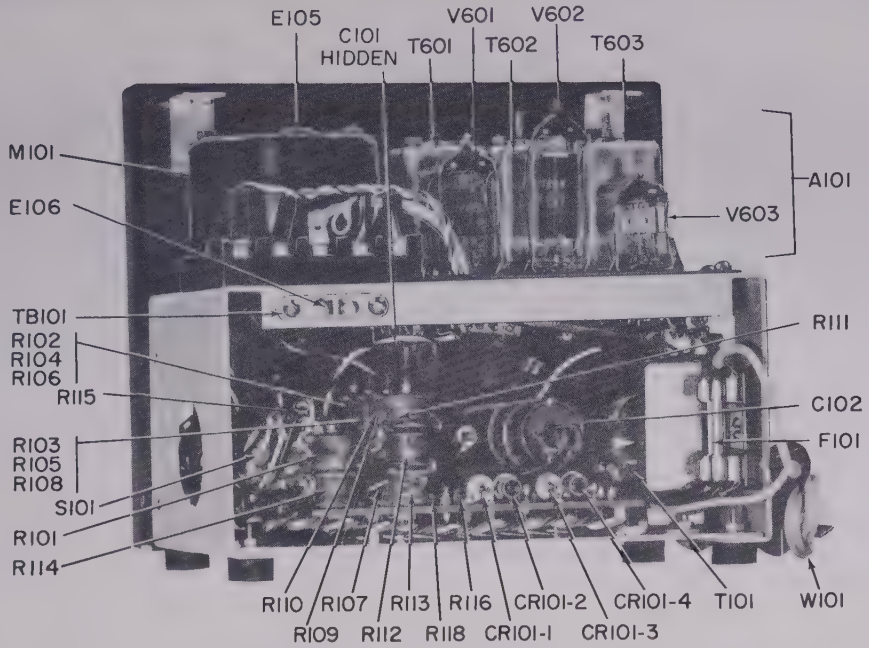


Figure 5-2. Model 1477, Rear View with Case Removed

CIRCUIT SYMBOL	DESCRIPTION	WESTON PART NO.	QTY
	(See Figures 4-2, 5-1 and 5-2)		
A101	AMPLIFIER, DIFFERENTIAL: Weston Model 9950	186610-901	1
*C101	CAPACITOR, FIXED, CERAMIC, DIELECTRIC: 0.02 mfd; 500 vdcw; ±20%; Erie Type 811	ND 24848-001	1
C102	CAPACITOR, FIXED, ELECTOLYTIC: 8 mfd; 450 vdcw; ±20% (each section); Cornell-Dubilier Type BBRD-8D45	ND 38566-001	1
E101	POST, BINDING: 6-way; E.F. Johnson No. 111-113 (Gray); "+" input terminal	ND 37919-901	1
E102	POST, BINDING: 6-way; E.F. Johnson No. 111-103 (Black); "–" input terminal	ND 37919-902	1
E103	POST, BINDING: Same as E102; Grounding terminal		1
E104	LEAD, ELECTRICAL: Input jumper link (not shown)	183646-024	1
E105	ADJUSTER, GALVANOMETER: Electrical adjustments (part of M101)		1
E106	LEAD, ELECTRICAL: Output jumper link	186669-901	1
F101	FUSE, CARTRIDGE: 1 amp; 250 volts; Littelfuse Type 3AG; Series No. 312000	ND 38586-001	1
H101	KNOB: Function Selector (Black); Dumont Labs. No. 45003341; used with S101	ND38560-001	1
H102	KNOB: Range Selector (Clear lucite); Dumont Labs. No. 45003332; used with S101	ND 38462-001	1
H103	ADJUSTER, METER POINTER: Mechanical Adjustments	156279-901	1
M101	GALVANOMETER, INDUCTRONIC: Weston Model 1401	132167-901	1
M102	MILLIAMMETER, DC: Panel indicator; 0-1 ma; Weston Model 1971	186661-901	1

*See Figure 5-3

CIRCUIT SYMBOL	DESCRIPTION	WESTON PART NO.	QTY
R101	RESISTOR, FIXED, WIRE WOUND: 100 ohms; ±0.1%	186838-901	1
R102	RESISTOR, FIXED, WIRE WOUND: 10 ohms; ± 0.1%	186832-901	1
R103	RESISTOR, FIXED, WIRE WOUND: Same as R102		1
R104	RESISTOR, FIXED, WIRE WOUND: 30 ohms; ± 0.1%	186836-901	1
R105	RESISTOR, FIXED, WIRE WOUND: 18 ohms; ± 0.1%	186834-901	1
R106	RESISTOR, FIXED, WIRE WOUND: 15 ohms; ± 0.1%	186833-901	1
R107	RESISTOR, FIXED, WIRE WOUND: Same as R102		1
R108	RESISTOR, FIXED, WIRE WOUND: 20 ohms; ± 0.1%	186835-901	1
R109	RESISTOR, FIXED, WIRE WOUND: Same as R102		1
R110	RESISTOR, FIXED, WIRE WOUND: Same as R104		1
R111	RESISTOR, FIXED, WIRE WOUND: 50 ohms; ± 0.1%	186837-901	1
R112	RESISTOR, FIXED, WIRE WOUND: Same as R101		1
R113	RESISTOR, FIXED, WIRE WOUND: 300 ohms; ± 0.1%	186839-901	1
R114	RESISTOR, FIXED, WIRE WOUND: 500 ohms; ± 0.1%	186840-901	1
R115	RESISTOR, FIXED, COMPOSITION: 150K ohms; ± 10%; 0.5w	ND 38563-001	1
R116	RESISTOR, FIXED, COMPOSITION: 200K ohms; ± 10%; 1 w	ND 38564-001	1
R117	RESISTOR, FIXED, WIRE WOUND: 4K ohms; ± 5%; 5 w	ND 38557-001	1
R118	RESISTOR, FIXED, COMPOSITION: 47 ohms; ± 10%; 0.5 w	ND 38568-001	1

CIRCUIT SYMBOL	DESCRIPTION	WESTON PART NO.	QTY
S101	SWITCH, ROTARY: 12 position; dual concentric shafts; used with H101 and H102	186665-001	1
T101	TRANSFORMER, POWER: Stancor No. PS 8416	ND 38565-001	1
W101	CABLE, POWER, ELECTRICAL: 2 wire; Belden Cat No. 17106	ND 38613-001	1
CR101-1 to CR101-4	RECTIFIER: Silicon; Automatic Mfg. Type PT 540	ND 38567-001	4
DS101	LAMP, GLOW: General Electric No. NE-2; μA pilot light	ND 38562-001	1
DS102	LAMP, GLOW: Same as DS101; MA pilot light		1
TB101	TERMINAL BOARD: Miniature strip; Millen Mfg. No. KE302-A	ND 38589-001	1
	(For the following Parts see Figures 4-3, 5-2 and 5-3)		
C601	CAPACITOR, FIXED, CERAMIC, DIELECTRIC: 0.01 mfd; 500 vdcw; ± 20%; Erie Type 811	ND 24848-001	2
C602	CAPACITOR, FIXED, CERAMIC, DIELECTRIC: Same as C601		2
C603	CAPACITOR, FIXED, MICA: DI-ELECTRIC: 500 mfd; 600 vdcw; ± 10%; Cornell-Dubilier Type 5R	ND 23555-001	1
*C604 to C609	CAPACITOR, FIXED, CERAMIC, DIELECTRIC: Same as C601		7
L601	CHOKE: 200 kc; 10 mh; 70 ohms; ± 10%	132746-001	1
R601	RESISTOR, FIXED, COMPOSITION: 1K ohms; ± 10%; 0.5 w	ND 20128-001	1
R602	RESISTOR, FIXED, COMPOSITION: Same as R601		1
R603	RESISTOR, FIXED, COMPOSITION: 470 ohms; ± 10%; 0.5 w	ND 38644-001	1

*C605 consists of 2 sections

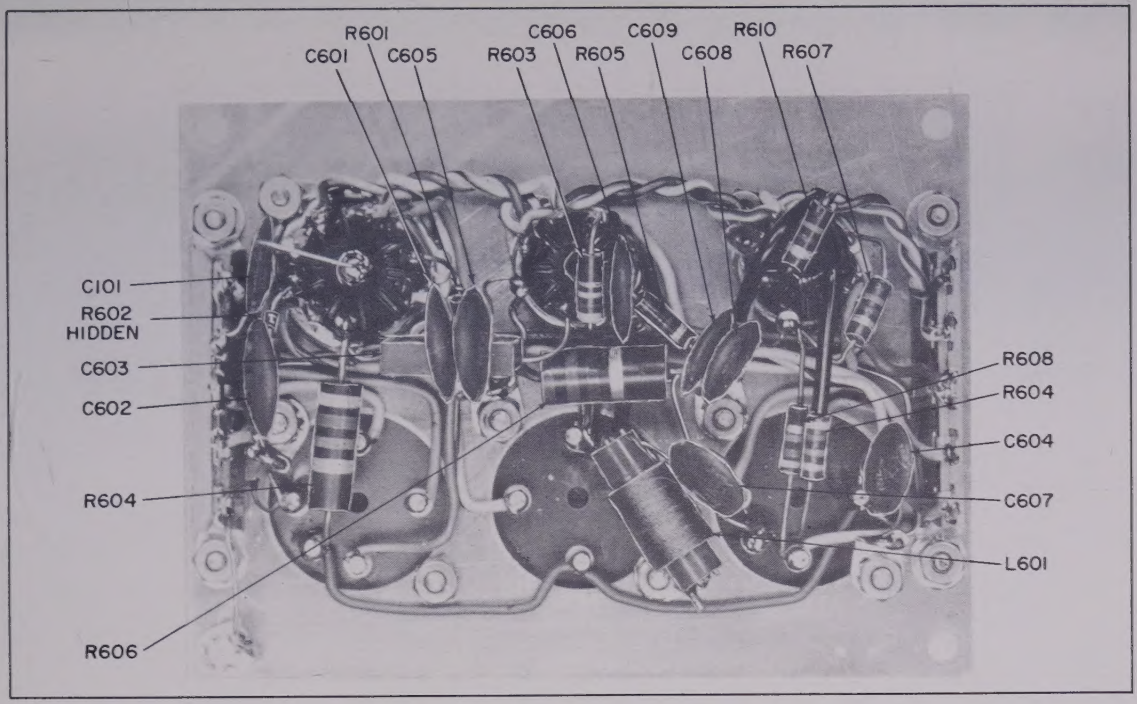


Figure 5-3. Model 9950 Amplifier, Bottom View

CIRCUIT SYMBOL	DESCRIPTION	WESTON PART NO.	QTY
R604	RESISTOR, FIXED, COMPOSITION: 47K ohms; ± 10%; 1 w	ND 27727-001	1
R605	RESISTOR, FIXED, COMPOSITION: 1 megohm; ± 10%; 0.5 w	ND 20401-001	1
R606	RESISTOR, FIXED, COMPOSITION: 1.8K ohms; ± 10%; 2 w	ND 24850-001	1
R607	RESISTOR, FIXED, COMPOSITION: 1.8K ohms; ± 10%; 0.5 w	ND 21091-001	1
R608	RESISTOR, FIXED, COMPOSITION: 47K ohms; ± 10%; 0.5 w	ND 20594-001	1
R609	RESISTOR, FIXED, COMPOSITION: Same as R608		1
R610	RESISTOR, FIXED, COMPOSITION: Same as R607		1
T601	TRANSFORMER, INPUT: 200 KC	186614-901	1
T602	TRANSFORMER, INTERSTAGE: 200 KC	186614-902	1
T603	TRANSFORMER, DISCRIMINATOR: 200 KC	186614-903	1
V601	TUBE, ELECTRON: 12AX7 (2 sections); RCA	ND 38577-001	1
V602	TUBE, ELECTRON: 6AQ5; RCA	ND 38576-001	1
V603	TUBE, ELECTRON: 6AL5; RCA	ND 38581-001	1

www.manualsplus.com
1037389